

Attorney Docket No.: F064

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPL. NO.: 09/765,806 ART UNIT: 2881
APPLICANTS: Robert L. Gerlach et al. EXAMINER: Mary A. El-Shammaa
FILING DATE: 01/19/2001
TITLE: Shaped and Low Density Focused Ion Beams

RESPONSE TO OFFICE ACTION

Commissioner for Patents
Washington, D.C. 20231

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Applicants responds as follows to the January 13, 2003 Office action.

Claims 1-7, 19-27, 29, and 30 stand rejected under 35 U.S.C. 102(a) as anticipated by U.S. Pat. No. 6,277,542 to Okino et al. ("Okino"). Applicants respond as follows.

Applicants' invention relates to ion beam systems. Such systems are typically used to mill (that is, micromachine) a work piece by precisely sputtering atoms of molecules from the work piece. The milling of some materials can be enhanced using chemicals, such as iodine, that combine in the presence of the ion beam with the work piece atoms to form volatile byproducts. The ion beam can also be used to deposit material by decomposing a molecule adhered to the surface. The molecule decomposes to form one decomposition product that is deposited and other decomposition products that are volatile and are removed. For example, a gas jet of organometallic molecules can be directed to the impact point of the ion beam, and the ion beam will decompose the organometallic molecules adhered to the surface to deposit a metal layer onto the surface.

CERTIFICATE OF FACSIMILE

I hereby certify that this paper or fee is being transmitted via facsimile to the Commissioner for Patents, Washington, D.C. 20231, 14th day of April, 2003.

By:
Name:

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Okino, on the other hand, describes an exposure system for a charged particle beam lithography system. The charged particle beam system of Okino neither deposits nor removes material from the work piece. The lithography system of Okino projects the pattern of a reticle onto photoresist on a wafer, causing a chemical change in the photoresist. The beam does not remove the photoresist and it does not deposit the photoresist. As described in col. 10, lines 25-35, and shown in FIG. 8, after exposure to the charged particle beam, Okino performs a development step (typically a wet chemical etch) after exposure to remove either exposed or unexposed portions of the photoresist.

Regarding claim 1, the Examiner cites col. 6, lines 40-47, as teaching that "the ions in the beam induce a reaction of the working material to deposit or remove material from the target." Col. 6, lines 40-47, describes exposing the photoresist on the target to the beam. The beam does not deposit or remove the photoresist. Removing the photoresist is done in a subsequent development step, typically using a wet chemical etch. Moreover, the claim recites "inducing a reaction of the working material to deposit material onto the target or to remove material from the target." If the Examiner is taking the photoresist to be the "working material," claim 1 is also different from Okino because the beam of Okino affects only the working material and does not depositing or removing material from the target as claimed.

Because Okino teaches a lithography exposure system and does not teach charged particle beam etching or deposition, Okino also does not teach the claim 1 limitation of "directing a jet of working material towards the target."

The examiner states that Okino forms an image of aperture (106) on the target, citing col. 6, lines 15-16, 31-33, and 55-65. Applicants submit that Okino forms an image of the aperture on reticle 110, and then forms an image of reticle 110 on the target. "As the illumination beam strikes reticle 110, the beam forms an image of the beam shaping aperture 106 on the illuminated exposure region of the reticle 110. Col. 6, lines 31-33. "The imaging beam is deflected as required by the deflector system 131 to form an image of the exposure unit [reticle] at the desired fixed location on wafer 114." Col. 6, lines 63-65.

The Examiner also cites col. 6, lines 15-16, 31-33, and 55-65 as teaching that said aperture can have a straight edge positioned in the path of the ions near the beam center. FIG. 4

shows the opening of aperture 106 centered on the beam, and no edge of the aperture is near the beam center.

The examiner cites col. 4, lines 61-67, and col. 5, lines 1-7, as teaching that the ion beam can be underfocused to produce a uniform current density at the target surface. "Underfocused" means focused beyond the target plane. For example, applicants' FIG. 3 and specification, page 22, second full paragraph, show and describe a target plane 148 and a focal point 148 well below the target plane.

Because Okino is transferring an image onto the photoresist surface, it teaches focusing the charged particle beam on the wafer surface. For example, col. 6, lines 63-65, and col. 7, lines 5-7, describes forming an image of the illuminated exposure unit at the desired location on the wafer. There is no teaching of underfocusing. Okino needs to focus the image of the reticle onto the target plane to transfer the reticle pattern to the photoresist with high resolution. If the exposure beam were not focused, a clear pattern would not be transferred. Underfocusing the reticle image would render the system of Okino unworkable.

Okino teaches allowing a small number of electrons to penetrate large "blocked" areas so that the current density within large blocked areas is more similar to the current density caused by beam aberration within small blocked areas surrounded by unblocked areas. By "unblocking" small areas that are too small to "print," Okino purports to make the current density of blocked areas, large and small, more uniform. Okino does not change the focus of his system.

Regarding claim 6, the Examiner states that Okino discloses "etching or depositing and repeating a pattern corresponding to the ion beam onto the target" in col. 9, lines 10-15 and 31-34. Col. 9, lines 10-15 and lines 31-34 state that etching or ion beam etching can be used to form the microfeatures in the reticles used in lithography process. It does not state or imply that the lithography system described in Okino performs ion beam etching and creates the reticle that it uses. There is no indication that the ion beam etching used to form the reticle is anything other than conventional focused ion beam etching.

Regarding claim 19 and 22, the Examiner cites col. 6, lines 55-65 and col. 8 lines 51-54 as disclosing a system having a "first and second lens (112, 113) wherein the first lens can be configured to form an image of the ion source at the second lens plane by placing the target 114

at the same plane as the second lens, and an aperture positioned between the first and second lens." Applicants submit that Okino does not teach forming an image of an ion source at all and does not place an aperture between lenses 112 and 113.

Regarding claims 23-25, 27 and 29, as described above, applicants submit that Okino does not teach a knife edge aperture and does not teach focusing an ion beam on a plane beyond the target plane.

Claims 9 and 11-13 stand rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Pat. No. 6,303,932 to Hamamura et al. ("Hamamura"). Applicants submit that Hamamura does not teach a "non-Gaussian, shaped beam" as recited in claim 9.

Claims 8, 10, 14, 15, 17, and 18 stand rejected under 35 U.S.C. 103(a) for obviousness over Okino in view of Hamamura. Applicants submit that these claims are patentable for the reasons described above with respect to the anticipation rejections.

Claims 16 and 28 stand rejected under 35 U.S.C. 103(a) for obviousness over Okino in view of Hamamura and further in view of U.S. Pat. No. 4,724,369 to Roussin. The term "chromatic aberration limited" indicates that the chromatic aberration is the limiting factor in focusing the beam, that is, other sources of aberration are less important than the chromatic aberration. Roussin does not indicate which type of aberration limits the focusing of his system.

For the reasons described above, applicants submit that the claims differentiate over the cited references and respectfully requests that the application be allowed.

Respectfully submitted,

Date: 4/14/03

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April 14, 2003

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Austin, TX 78716-4140**Phone:** (512) 328-9510**Fax:** (512) 306-1963**Date:** April 14, 2003**Atty Docket No.:** F064**Pages:** 5 Pages (Including this coversheet)**APPL. NO.:** 09/765,806**ART UNIT:** 2881**APPLICANT:** Robert L. Gerlach et al.**EXAMINER:** Mary A. El-Shammaa**FILING DATE:** 01/19/2001**TITLE:** Shaped and Low Density Focused Ion Beams**FAX RECEIVED**

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In connection with the above-identified patent application, applicants submit the following:

1. Fax Cover Sheet
2. Response to Office Action

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